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CONTINUOUS AND DISCRETE GAMMA RAYS EMITTED IN THE DECAY OF
Pd¹⁰³

Doctors L. H. Th. Rietjens, H. J. van den Bold and P. M. Endt of the State University at Utrecht, The Netherlands, have measured the gamma rays resulting from the decay of Pd¹⁰³ by electron capture. This decay (half-life 17 days) is to Rh^{103*} (56 min) which subsequently decays by the emission of a strongly converted 40 kev gamma ray to the Rh¹⁰³ ground state. The β^- decay of Ru¹⁰³ has established the existence of excited states in Rh¹⁰³ at 40 kev, 53 kev, and 538 kev. The original object of the investigation was to measure the shape, intensity and endpoint of the continuous gamma ray spectrum (internal bremsstrahlung) since no discrete gamma rays had been reported from this isotope except for the easily absorbable 40 kilovolt gamma ray from Rh^{103*}. The discovery of a number of weak discrete gamma rays has hampered the investigation but on the other hand it has allowed a fairly precise determination of the spin and parity of Pd¹⁰³ and of the Pd¹⁰³-Rh¹⁰³ mass difference. The usual type of NaI scintillation spectrometer was used with a differential discriminator. Sources of Pd¹⁰³ were produced by the (d,2n) (d,p) and (d, α 2n) reactions on appropriate targets. Chemical purification was used in each case. The gamma rays shown in the accompanying table were observed. The discrete gamma rays definitely come from Pd¹⁰³ for the following reasons. The relative intensities of the lines were independent of the nuclear reaction by which the source was produced. The

		Energy (kev)	Intensity ^o
discrete γ-rays	γ ₁	503 ± 8	0.012 ± 0.002 ^o / _o
	γ ₂	367 ± 6	0.06 ± 0.007 ^o / _o
	γ ₃	305 ± 8	0.011 ± 0.003 ^o / _o
	γ ₄	(262 ± 15)	(0.004 ± 0.002 ^o / _o),
continuous γ-spectrum		494 ⁺²⁷ -12 (endpoint)	0.018 ^o / _o ^f (total intensity)

^o Per unit disintegration

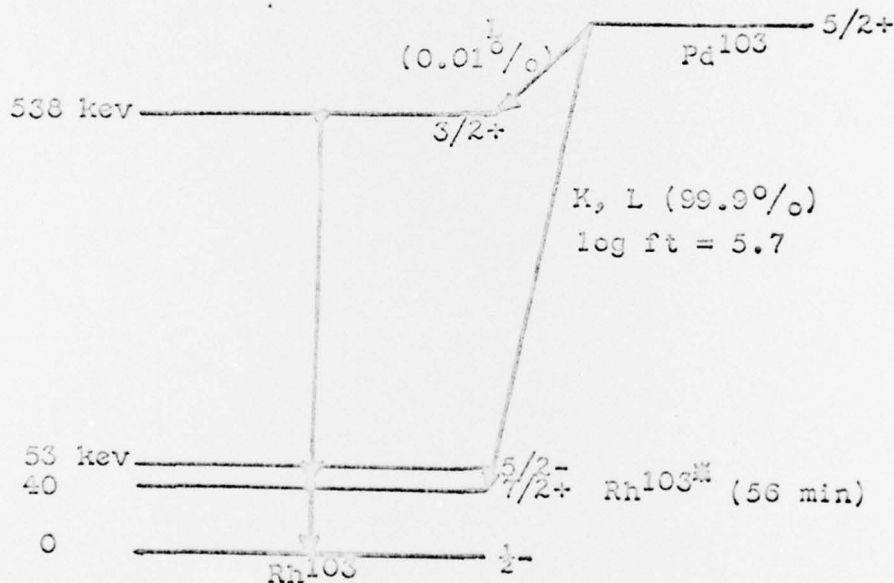
^f Computed from endpoint energy

half-lives of all the gamma rays were the same. Finally, the 503 kev gamma ray ascribed to Pd¹⁰³ agrees in energy with the 498 kev gamma ray found in the decay of Ru¹⁰³. The fact that the 503 kev gamma ray is not due to positron annihilation was proven by a simple angular correlation experiment. Because of the presence of the discrete gamma rays the endpoint energy of the continuous spectrum could only be roughly estimated at 500 - 600 kev. The accompanying figure shows the proposed decay scheme for Pd¹⁰³. The ground state of Rh¹⁰³ is p_{1/2} so the spins of the 40, 53 and 538 kev levels are uniquely determined as

$$J = 7/2^+, 5/2^- \text{ and } 3/2^+$$

from the measured K-L conversion ratios of the gamma rays by which they are de-excited and from the upper limit of 2×10^{-8} sec given for the lifetime of the 538 kev level. The main Pd¹⁰³ decay to Rh¹⁰³⁺ is allowed. This limits the Pd¹⁰³ spin to either 5/2⁺, 7/2⁺, or 9/2⁺. Thus the Pd¹⁰³ decay to the 538 kev level ($J = 3/2^+$) is either allowed or second forbidden. Requiring a log ft-value corresponding to a second forbidden transition would mean that the transition energy would have to be many Mev to correspond to the known lifetime and branching ratio

(0.11%). Thus these research workers conclude that the Pd103 decay to the 538 kev level is allowed and this determines the Pd103 spin to be $J = 5/2^+$. This is in accordance with the shell model prediction of $s_{1/2}$, $d_{5/2}$ or $g_{7/2}$. This then also allows one to determine the Pd103 mass. Assuming that the log ft-value of allowed transitions is between 4.5 and 7.0, one finds that the decay energy for this transition is 19^{+27}_{-12} and the corresponding Pd103-Rh103 mass difference is 557^{+27}_{-12} kev. The other gamma rays observed presumably indicate the presence of other excited states in Rh103 having negative parity and fed from Pd103 by first forbidden electron capture transitions.



NON-INTERACTING AND NON-DECAYING K-MESONS

Prof. Sten von Friesen and his co-workers K. Kristiansson and E. Alinder at the University of Lund, Sweden, have observed two K mesons which stop in G5 emulsion but show no decay or visible interaction at the end of their range. These mesons were identified from their mass measurement by the recently improved photo-electric method developed at Lund. As an indication of the accuracy of the method, measurements on protons having a residual range of 4 or 5 mm give a distribution of mass-values with a standard deviation of 10% . For corresponding measurements on particles of mass $1000 m_e$ a range of only 2 or 3 mm is required. Of 120 slow heavy particles measured in 400 micron G5 emulsions exposed at 100,000 feet, 99 were protons, 14 deuterons and 4 tritons. Only 3 particles had abnormal masses. They were:

$$K_{Ld1} = 905 \pm 70 m_e \quad \text{Range} = 3450 \text{ microns}$$

$$K_{Ld2} = 960 \pm 70 m_e \quad \text{Range} = 3300 \text{ microns}$$

$$K_{Ld3} = 890 \pm 90 m_e \quad \text{Range} = 5700 \text{ microns}$$

The emulsions containing K_{Ld1} and K_{Ld2} had been developed to $g \text{ min} \sim 25$ but no sign of decay or interaction was observed at the end of their range nor were there any electron pairs in the vicinity. The development of the emulsion containing K_{Ld3} was not adequate to observe a decay in that case. Von Friesen suggests that these mesons may be negative kappa mesons which have a very small nuclear interaction.

TWO K-MESON EVENTS OBSERVED AT PADUA

Doctors M. Baldo, M. Ceccarelli, M. Grilli and B. Vitale at the University of Padua have observed two unusual K-meson events in a stack of stripped emulsions flown at an altitude of about 80,000 ft for 7 hours. The first is the nuclear capture of a K^- meson and the second is a decay of a K^+ meson into a low energy pion. The K^- particle is produced in a disintegration of the type 6-lp and comes to rest after 11 mm in the emulsion where it produces a star composed of four black tracks, probably two protons,

a short recoil track, and a grey pion track; the latter coming to rest in the emulsion after 22 mm. The measured mass is $1070 \pm 160 m_e$ obtained as a weighted average from ionization-range measurements and scattering-range measurements by the constant sagitta method. The total visible energy produced in the nuclear capture of the K^- meson is 252 Mev composed of 96 Mev kinetic energy, 140 Mev rest energy of the pion, and 16 Mev binding energy of the protons. This nuclear capture of a negatively-charged heavy meson was the only case observed in the scanning of 40 cc of emulsion in which 1200 π^- capture stars were observed (see also ESN No. 8-1).

The second heavy meson is produced in a nuclear disintegration of the type $8 + 3n$ with an ionization of $3.6 \times \text{min}$. After a range of 13 mm it comes to rest in the emulsion where a secondary particle is emitted which in turn comes to rest after 900 microns where it decays into a muon. Finally, the electron secondary from the muon is observed. The particulars of the particles involved in this chain of disintegration are shown in the accompanying table. The Padua research group interprets

Mass (m_e)	Identity	Range (μ)	Energy (Mev)
966 ± 100	K	13,150	-
220 ± 70	π^+	900	6.0
-	μ	603	4.4

this event to be the decay at rest of a Σ^+ meson into a π^+ meson and, at least, one neutral particle. One possible disintegration scheme is $\Sigma^+ \rightarrow \pi^+ + \pi^0 + \pi^0$. Theoretically at least 20 per cent of the Σ mesons should decay by this scheme. The possible interpretation of this event as the capture of a K-meson by a nucleus with the successive emission of a positively-charged pion, is not regarded as very likely.

COLOR CENTERS IN QUARTZ

Dr. E.W.J. Mitchell at the University of Reading has for the past year been studying the optical absorption bands in neutron-irradiated quartz. The investigation is an empirical one, such as the early study of color centers in alkali halides. Both natural quartz crystals and fused quartz specimens were irradiated with neutrons in the Harwell pile for about a week, and the optical absorption of the colored samples was measured as a function of frequency. The band formation of the neutron-irradiated specimens, which was found to be similar to that of X-ray colored specimens, is shown in Fig. 1.

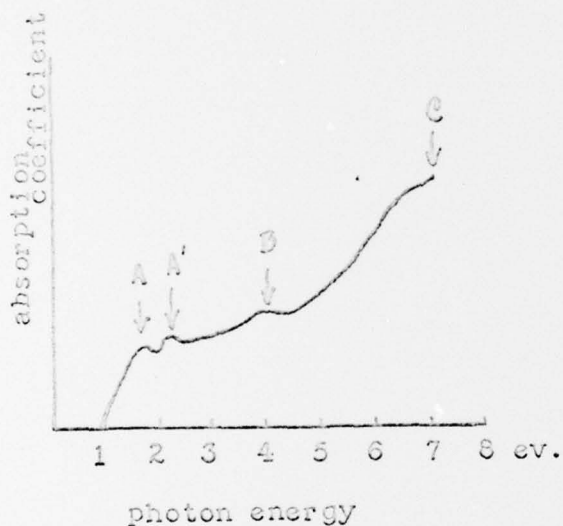


Fig. 1

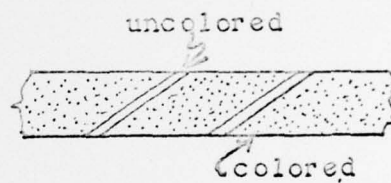


Fig. 2

Irradiation in the C-band was observed to produce bleaching in all of the bands, thus indicating that the same "center" is at least partly responsible for the entire band structure. All of the bands bleach by about the same amount.

Experiments are in progress to correlate variations in coloring in the crystal with the strain pattern or with the crystal orientation. In some of the natural crystals, it was observed that narrow, sharply-bounded regions in the colored neutron-irradiated crystal were completely uncolored (see Fig. 2); this observation has not been explained.

MAGNETOPHOTOMECHANICAL EFFECT IN GERMANIUM

Dr. P. R. Aigrain at the Ecole Normale Supérieure is continuing semiconductor research with germanium and is beginning similar work with silicon. Special thorium crucibles prepared by Compagnie Générale de Téléphone sans Fil (C.S.F.) will be used for adding impurities to the silicon and to grow single crystals.

Previous work (see ONRL-21-53 and Comptes Rendus 236, 595-596 and 672-674 (1953)) on the magnetophotovoltaic effect in germanium has been partially shifted to the newly discovered magnetophotomechanical effect. A symmetric (cylindrical) sample is suspended between the poles of an electromagnet by a torsion wire in line with the cylinder's axis. Light is allowed to fall on one side of the cylinder by means of a light shield and the cylinder is found to rotate, due to the torque set up by the interactions of the magnetophotovoltaic currents and the magnetic field. Rotations as large as two revolutions of the specimen have been observed.

Aigrain believes that this will be a sensitive way for the measurement of mobilities and lifetimes of carriers. In particular, since the effective mobility

$$\frac{\mu_e \mu_p}{\mu_e + \mu_p}$$

is involved, there exists the attractive possibility of measuring the smaller of two mobilities when their difference is large. For example, Aigrain thinks that it will be possible to measure the hole mobility in CdS or possibly even the mobility corresponding to transitions between suitable impurity levels.

INSTITUTE FOR MACROMOLECULES

The Institute for Macromolecules at the University of Strasbourg will move in the summer of 1954 into a modern laboratory building, costing with the equipment about two hundred and sixty million francs (approximately \$750,000). This Institute, organized in 1947, is under the direction of Prof. C. Sadron. Dr. H. Benoit is Deputy Director and Head of the Physics Division. The Chemistry and Biology Divisions are under J. Parrod and R. Vendrely respectively.

Within the Physics Division are Dr. R. Cerf (theory); M. Dauve (dielectric constant and Kerr effect); P. Homaud (light scattering); and Leray (birefringence).

Studies on Turbulent Flow

Prof. H. Wayland of the California Institute of Technology is spending a year at the Institute for Macromolecules. He is using the techniques of streaming birefringence in an attack on the general problem of turbulent flow. A suitably birefringent liquid or liquid solution is placed between concentric cylinders, one of which rotates, and a plane-polarized monochromatic light beam is passed through the liquid in a direction parallel to the axis of rotation. The optical anisotropy of the molecules in the liquid is measured as a function of distance from the axis of rotation, and thus the stream lines are indicated. It is hoped to study the onset of turbulence in this way.

A recent improvement has been to coat the surface of the cylinders with a dielectric material in order to minimize difficulties with grazing incidence reflection when using the light beam close to the wall. An aluminum cylinder oxidized with sulfuric acid has been found to be a distinct improvement. This is because the phase changes on reflection by a dielectric material are 180° and the relative intensity changes are small. This is in contrast with metallic reflection where the two components of a plane polarized wave suffer more complicated phase and intensity changes and thus serve to confuse the birefringence measurements. Efforts are being made to treat the various stainless steel cylinders at this laboratory by commercial lacquering processes to make them more usable.

Molecular Weight of Silk

A recent result of light scattering measurements by Prof. Sadron and Mr. Hyde is the determination of the molecular weight of natural silk. The silk is dissolved in an organic solvent and scattering measurements are made at various dilutions. By extrapolating to infinite dilutions a value of 400,000 has been found which seems quite independent of solvent and preparation treatments. Previous estimates for this molecule were of the order of 100,000.

BOND ENERGIES IN ORGANOBORON COMPOUNDS

Dr. H. A. Skinner and Mr. N. B. Smith (Manchester) have recently determined the heat of hydrolysis of dimethylaminodichloroborane, $B(NMe_2)Cl_2$, and the heat of hydrolysis in hydrochloric acid of bis(dimethylamino)chloroborane, $B(NMe_2)_2Cl$. These data enable them to derive the heats of formation of these compounds in the liquid state and thus to complete the thermal data for the interesting series of boron compounds, $B(NMe_2)_nCl_{3-n}$, where $n = 0, 1, 2$ or 3 (cf. Skinner and Smith, J. Chem. Soc. 1953, 4025). It is found that the bond energy values for $B-Cl$ and $B-NMe_2$ are not constant in this group; the deviation from constancy is interpreted in terms of a molecular orbital treatment of back coordination in the "mixed" ($n = 1$ or 2) molecules as compared with the "pure" ($n = 0$ or 3) ones. Quantitatively it is found that the $B(NMe_2)Cl_2$ and $B(NMe_2)_2Cl$ molecules are stabilized to the extent of 12.1 and 6.9 Kcal/mole respectively, compared to what their stability would be if the $B-Cl$ and $B-NMe_2$ bonds in these molecules had the same energy as in BCl_3 and $B(NMe_2)_3$.

As mentioned above, the enhanced stability of these mixed molecules is explained by these workers by considering π bonding or back coordination. In view of the existence of a vacant $2p_z$ orbital on the boron atom, a certain amount of π bonding would be expected in molecules of the BX_3 type. The present results can be satisfactorily explained if it is assumed that back coordination from nitrogen to boron is stronger than that from chlorine to boron, and an attempt is being made to correlate these observations with the variable acceptor properties of different EX_3 molecules.

Full details of this work will appear in the J. Chem. Soc., London.

SELF-BRANCHING IN POLYMERIZATION REACTIONS

At a recent meeting of the Royal Society J. C. Bevington, G. M. Guzman and Prof. H. W. Melville (Birmingham) reported some valuable new results on the problem of self-branching in addition polymerization for styrene and for vinyl acetate. Branching occurs when growing polymer radicals dehydrogenate already formed polymer molecules at random points along the chain. The new kind

of radicals so produced then grow branches by the addition of further units of monomer. A radioactive indicator technique was devised by these workers to determine the velocity coefficient of the dehydrogenation process which is needed to enable computation of the number of branches formed. A linear polymer of high molecular weight ($\sim 500,000$) was mixed with radioactive monomer and the latter was polymerized under conditions giving polymer of considerably lower molecular weight. The branches formed on the high molecular weight polymer will be radioactive. The high molecular weight material is then separated by precipitation and the weight fraction of branches in it is estimated from the measured radioactivity. The polymer radical concentration and the number of positions which can be attacked can be calculated from data already available from other work. Once the transfer coefficient is obtained it is possible to estimate the fraction of molecules having one, two or more branches under specified conditions.

Results were presented for styrene and for vinyl acetate and it is found that these behave quite differently. For styrene, branching is not important and its polymers are predominantly linear even after high temperature polymerization. For polyvinyl acetate, branching is pronounced even in the early stages of polymerization at temperatures as low as 25°C .

POLAROID LANTERN SLIDES FOR CLASS DEMONSTRATION OF HETERO-PHORIA

Dr. D. H. Smyth of the Department of Physiology, University of Sheffield, has developed a method using polarized light for a class demonstration of heterophoria by adapting lantern slides made of polaroid material. This has a considerable advantage for teaching purposes when compared with methods where a separate demonstration must be given to each individual. The usual principles are employed. A horizontal scale on the slide is projected with light polarized in one plane and an arrow above this with light polarized at right angles. The polaroid material is in the slide and an ordinary projecting lantern can be used. A 'silver' non-depolarizing screen must be used. When the screen is viewed directly, both eyes see both arrow and scale; when viewed through polaroid glasses, one eye sees the scale and the other the arrow. Heterophoria is shown by a different position of the arrow according to whether the screen is viewed directly or through polaroid glasses.

The polaroid glasses are made so that the plane of polarization is at 45° to the vertical; hence, viewing glasses turned upside down will reverse the arrow of displacement, while viewing with the glasses reversed (i.e., each eye looks through the polaroid previously in front of the other eye) will not alter its displacement.

HEAD HOLDER FOR RABBITS

Doctors C. Best, R. Bolam and C. S. Halpikie of the Physiological Research Unit, Medical Research Council, the Royal Free Hospital, Queen's Square, London, have devised a head holder for rabbits which provides a high degree of stability without causing injury to the animal. The head is immobilized by placing the mandible on two horizontal bars providing four supporting points of contact. Pressure is exerted on a central pad, which bears upon the dorsal surface of the nose immediately in front of the mouth. The head is fixed in the vertical axis. Horizontal stability is obtained by adjusting with thumb screws two vertical bars placed just anterior to the eyes, one on each side of the head. The head is advanced against the vertical bars so as to bring the bars into tight contact with the anterior edges of the inferior margins of the mandibles. The forward thrust of the skull against the vertical bars is rigidly maintained by exerting a pulling force on a horizontal bar which is inserted through the mouth behind the canine teeth.

OF CENTRAL NERVOUS SYSTEM

Auditory Cortex

C. B. B. Downman, Sherrington School of Physiology, Royal Free Hospital, London, in collaboration with W. G. Woolsey, University of Wisconsin, has used electrical stimulation and recording methods to examine the inter-relationships between different sub-areas of the auditory cortex. Auditory areas I and II were mapped by the method of Woolsey and Walzl (stimulation of nerve endings and recording of evoked potentials at cortex). Area I was then ablated and area II re-explored. It was found that cochlear stimulation still produced responses in area II.

This finding was true for the chronic as well as the acute preparation. Connections between analogous parts of areas I and II were demonstrated by electrical stimu-

tion of points in one region and picking up from points the other. Some evidence was obtained which suggests that area Ep may receive projections from the thalamus as well as from other parts of the auditory cortex and that the region straddling the descending anterior limb of the suprasylvian sulcus may receive independent thalamic projection.

F. Bremer, Laboratory of General Pathology, University of Brussels, has also been studying the interaction of different parts of the auditory cortex of the cat and the connections between the corresponding regions of the two cerebral hemispheres. In acute experiments he found that responses can be elicited from the lower region both by clicks presented to the ear and by electrical stimulation of anterior AI. After transection of the cortex between AI and Ep (sub-cortical damage being avoided), responses in Ep can no longer be elicited by stimulation of AI but can be by clicks. Responses can be evoked from points in AI or AII of one cerebral hemisphere by electrical stimulation of corresponding points in the opposite hemisphere. Bremer has repeatedly obtained records which indicate that a "third" auditory area exists in the region of somatic area II, near the tip of the descending branch of the anterior suprasylvian sulcus. Usually the active area is very small and lies just below the tip of the sulcus.

Activity of Isolated Cortex

M. K. Wright, Department of Anatomy and Neurosurgery, University of the Witwatersrand, Johannesburg, has carried out experiments in which he recorded the electrical activity of small isolated areas (approx. 7.5 x 15 mm) of the cortex of the cat. Care was taken to maintain the blood supply to the isolated areas and the cortex was protected by warm paraffin during the experiments. From isolated slabs in the suprasylvian and ectosylvian gyri, no spontaneous potentials were found and application of 1.25 per cent strychnine sulphate did not elicit spontaneous strychnine spikes. Electrical stimulation of the isolated region did produce strychnine spikes. In the study of the activity of isolated areas of the cortex, Wright stresses the importance of a histological check to confirm the fact that the area being examined has been completely separated from adjoining neural tissue; if even a few connecting fibers remain, the results of the experiment will be altered, i.e., spontaneous activity may occur.

Action of DFP

W. Feldberg and S. L. Sherwood of the National Institute for Medical Research, Mill Hill, London, have studied the effect of injecting DFP (diisopropyl fluo-phosphate) into the cerebral ventricle of the cat. The most pronounced effect was the production of a mild "catatonic-like" state. Some minutes after injection, the cat develops a drowsy appearance and allows itself to be placed in different unusual positions which it will maintain for some time. For example, the animal will crouch placidly with one foreleg bent behind its back, or it will stand on its hind legs resting its forelegs across a round of an upside-down stool. Further experiments are being done to clarify the chemo-neural mechanisms involved in this behavior.

A STATIC THRUST BALANCE FOR USE ON AIRFIELDS DEVELOPED BY DR. G. DATWYLER OF ZURICH, SWITZERLAND

A static thrust balance for airfield use in measurement of static thrust of jet-powered aircraft has been developed by Dr. G. Datwyler of Zurich, Switzerland. One unit has been built and installed on a Swiss military airfield where it has performed with sufficient effectiveness to lead to production of a second unit ordered by the Swiss Government and due for delivery in April 1954.

The balance consists of a platform which is flush with the airfield surface, having no protruding parts and hence presenting no obstacle to ground or flying operations. The aircraft to be tested rolls onto the platform under its own power, brakes to a stop, and is run up to the desired RPM. A pneumatic pickup below the platform receives the thrust developed which is then indicated on instruments at any convenient location such as the control tower (which is in radio contact with the aircraft). The pneumatic measuring system has a claimed accuracy of one part in ten thousand ($1/10,000$) with a very small displacement (.01 inches). It was originally developed for use with wind tunnel balances.

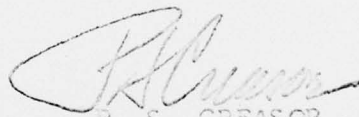
TECHNICAL REPORTS OF ONRL

The following reports have been forwarded to ONR, Washington. Copies may be obtained by addressing requests to the Commanding Officer, Office of Naval Research Branch

Office, Navy No. 100, c/o Fleet Post Office, New York, New York.

- ONRL-10-54 "Preston's Method of Measuring Turbulent Shear" by W. D. Hayes
- ONRL-12-54 "Some Aspects of Current Nuclear Physics Research in Scotland" by J. R. Richardson
- ONRL-15-54 "Research on the Structure of Arabic Acid" by A. L. Adkins
- ONRL-16-54 "Research in the Departments of Otolaryngology at the Universities of Utrecht and Amsterdam" by W. D. Neff

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